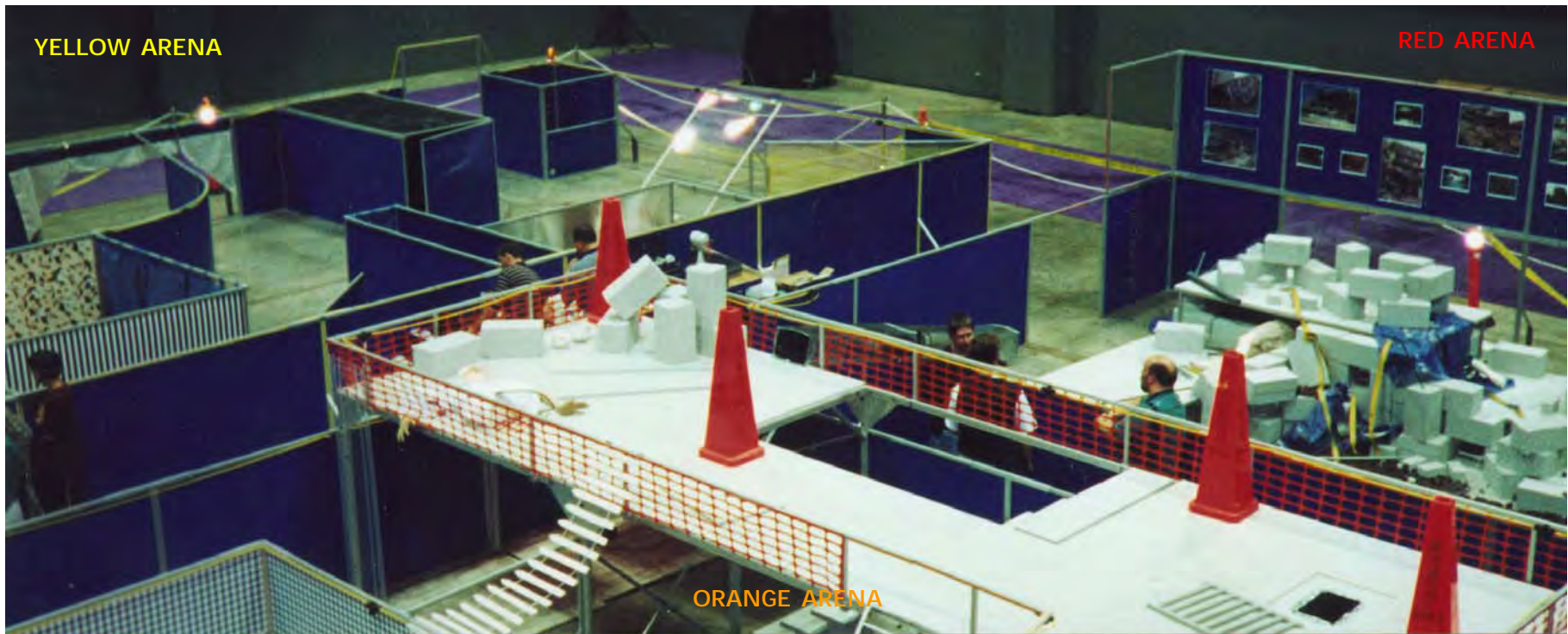


# REFERENCE TEST ARENAS FOR URBAN SEARCH AND RESCUE ROBOTS

**NIST**

National Institute of Standards and Technology  
Technology Administration, U.S. Department of Commerce



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# USAR Test Arena Proliferation

## *FOSTERING COLLABORATION THROUGH STANDARDS*

### PAST COMPETITIONS

**AAAI Conference 2000**  
AUSTIN, TEXAS, USA

**IJCAI/AAAI Conference 2001**  
SEATTLE, WASHINGTON, USA

**RoboCupRescue 2002**  
FUKUOKA, JAPAN

**AAAI Conference 2002**  
EDMONTON, ALBERTA, CANADA

**American Open 2003**  
PENNSYLVANIA, USA

**Japan Open 2003**  
NII GATA, JAPAN

**RoboCupRescue 2003**  
PADUA, ITALY

**IJCAI/AAAI Conference 2003**  
ACAPULCO, MEXICO

### YEAR-ROUND ARENAS

**NIST**  
MARYLAND, USA (2000)

**Museum of Emerging Science**  
TOKYO, JAPAN (2002)

**Carnegie Mellon University**  
PENNSYLVANIA, USA (2003)

**Instituto Superiore Anticendi**  
ROME, ITALY (2003)

### 2004 COMPETITIONS

**American Open**

**German Open**

**Japan Open**

**RoboCupRescue**  
LISBON, PORTUGAL

**AAAI Conference**  
CALIFORNIA, USA

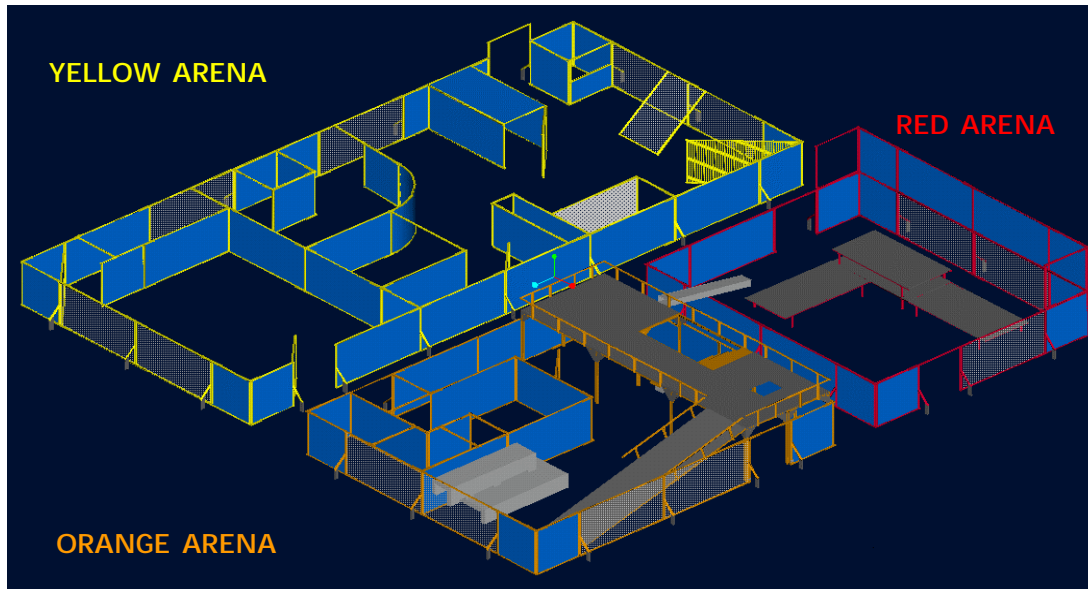
REFERENCE TEST ARENAS  
FOR  
URBAN SEARCH AND RESCUE ROBOTS

ARENA PROLIFERATION

NIST



# NIST'S REFERENCE TEST ARENAS for USAR ROBOTS



## YELLOW ARENA



## ORANGE ARENA



## RED ARENA



## YELLOW ARENA



## ORANGE ARENA



## RED ARENA



## YELLOW ARENA



## ORANGE ARENA



## RED ARENA



## TABLE OF CONTENTS

### Competition Set-Up Areas

- Square (preferred)
- Column
- Middle

### Yellow Arena

- 3-D Arena Model Images
- Floorplan and Wall Panel Fabrication List

### Orange Arena

- 3-D Arena Model Images
- Floorplan and Wall Panel Fabrication List
- Elevated Floor

### Red Arena

- 3-D Arena Model Images
- Floorplan and Wall Panel Fabrication List
- Collapsible/Pancake Floor

### Simulated Victims

- Signs of life
- Purchase list

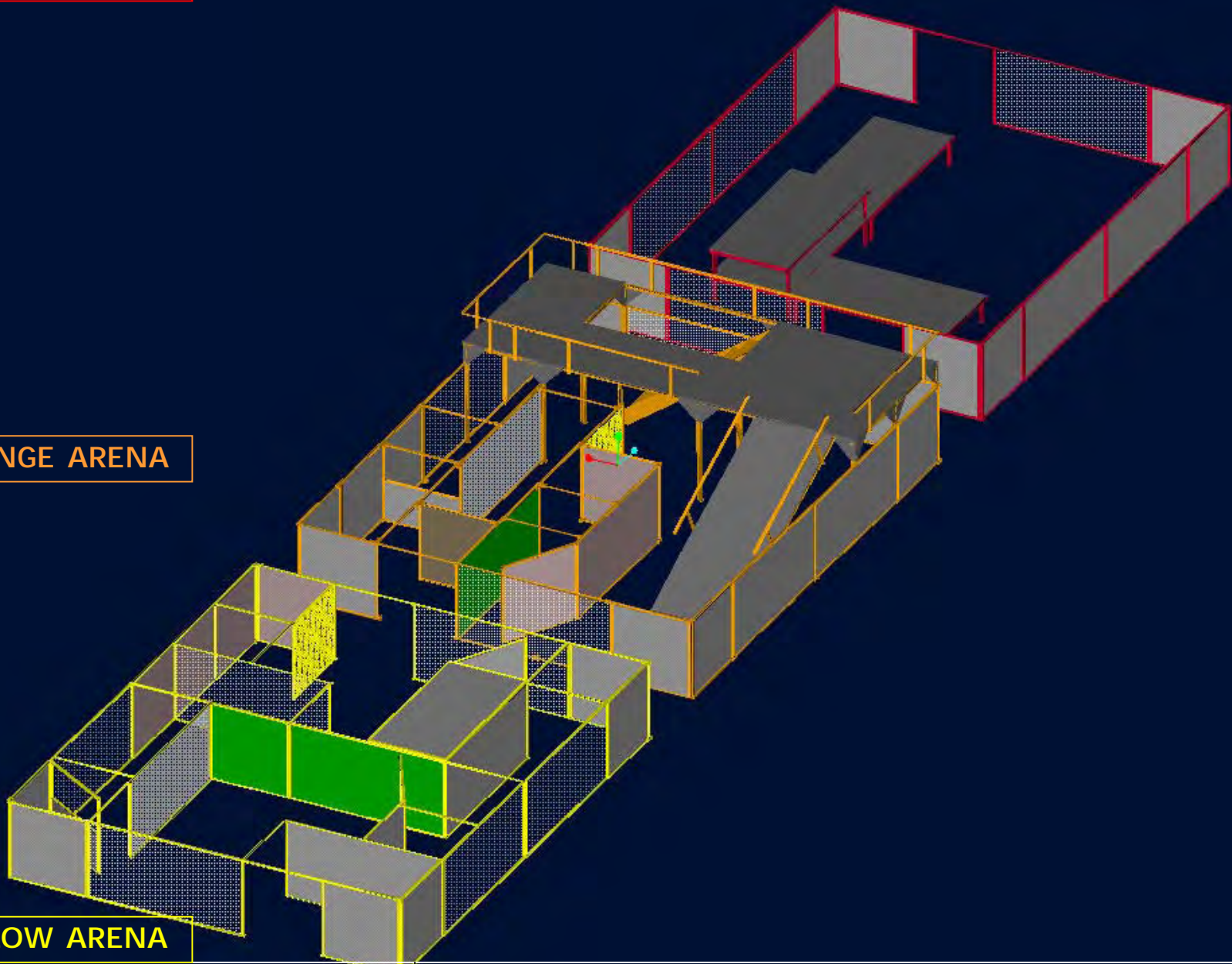
### Wall Panels

- Fabrication
- Connectors
- Assembly

RED ARENA

ORANGE ARENA

YELLOW ARENA



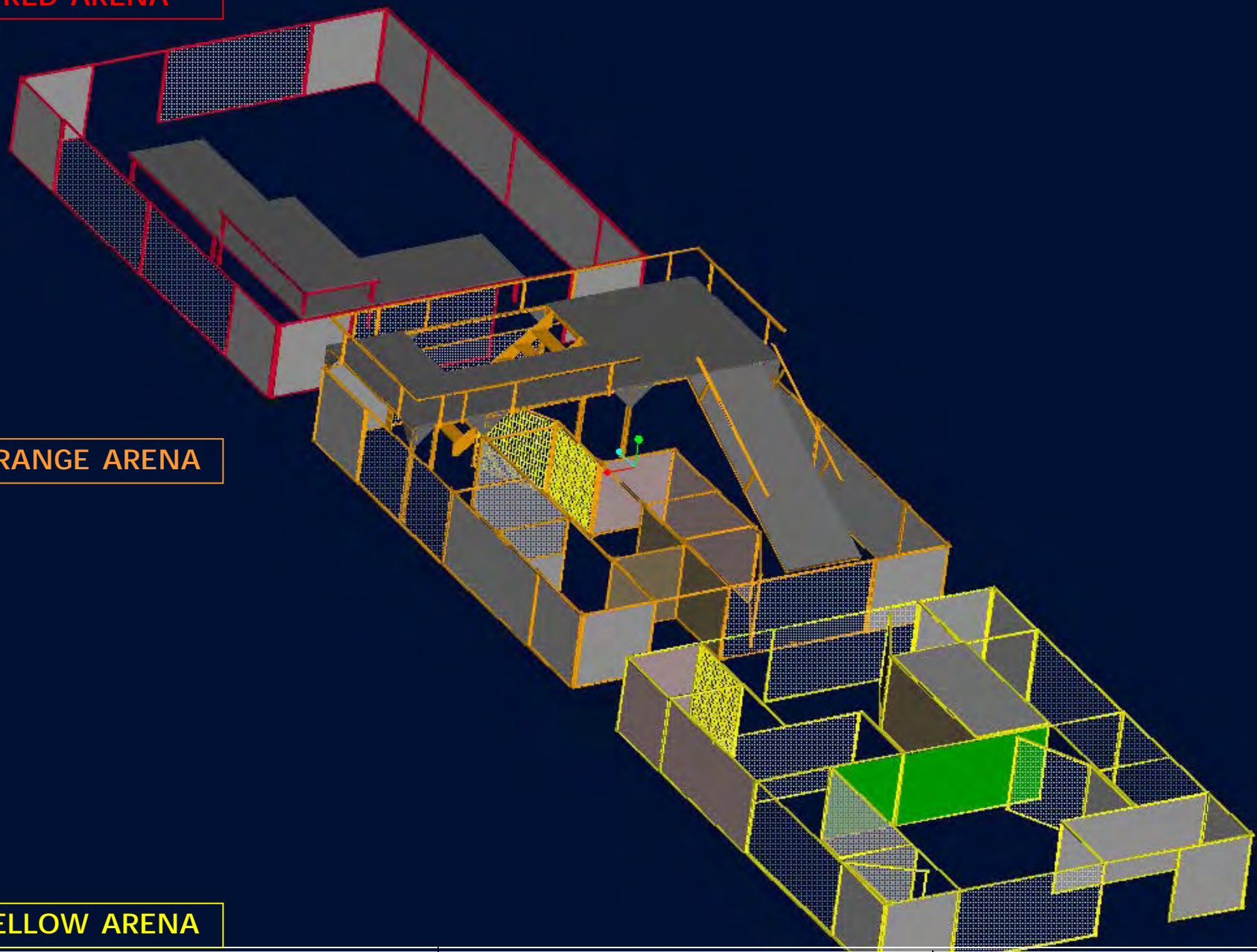
REFERENCE TEST ARENAS  
FOR  
URBAN SEARCH AND RESCUE ROBOTS

ALL THREE ARENAS

NIST



RED ARENA



ORANGE ARENA

YELLOW ARENA

REFERENCE TEST ARENAS  
FOR  
URBAN SEARCH AND RESCUE ROBOTS

ALL THREE ARENAS

NIST



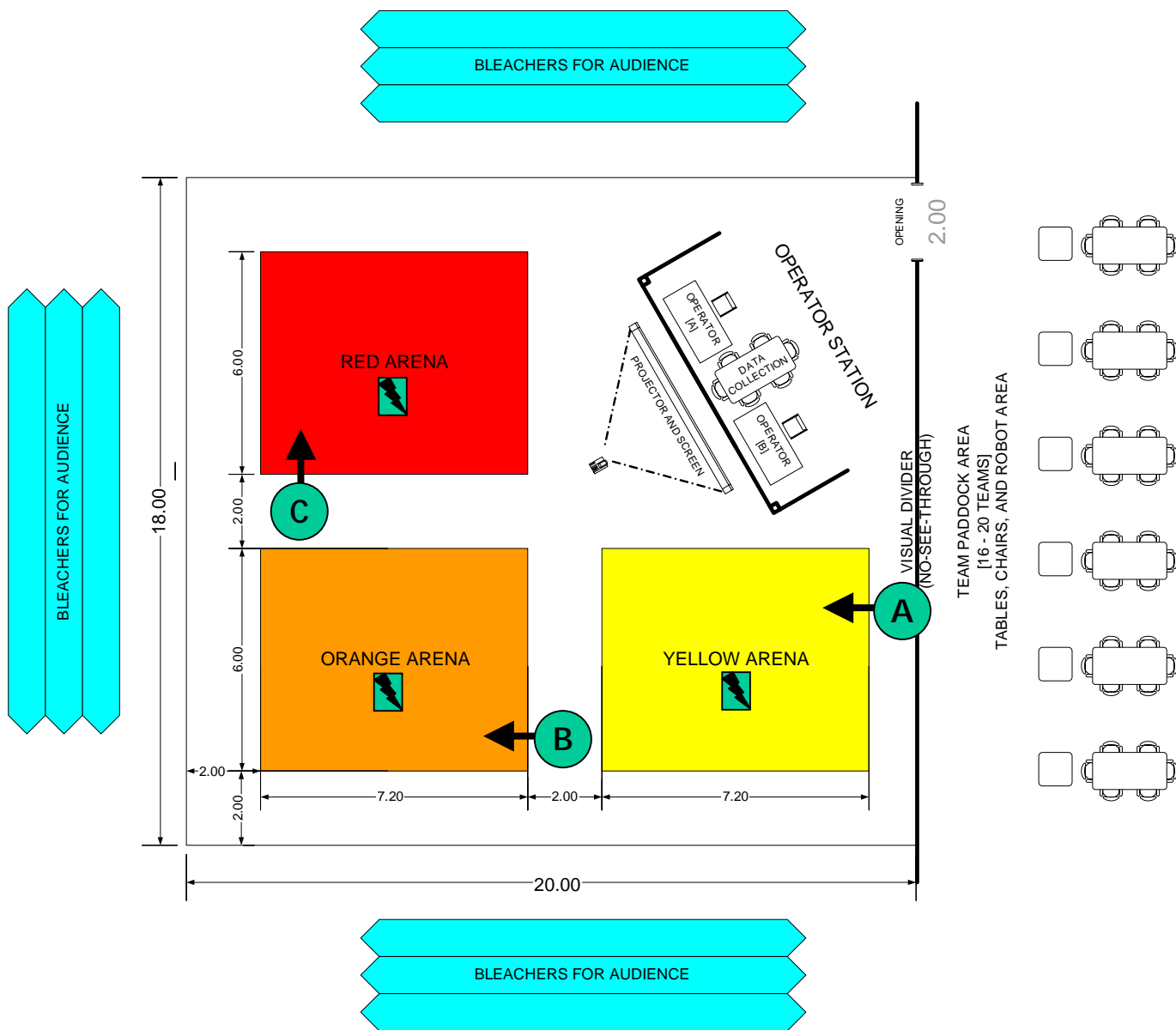



REFERENCE TEST ARENAS  
FOR  
URBAN SEARCH AND RESCUE ROBOTS

SOME SENSORY  
AND PHYSICAL OBSTACLES

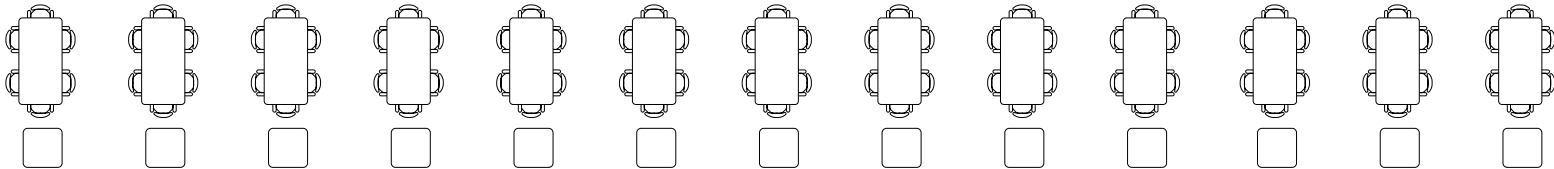
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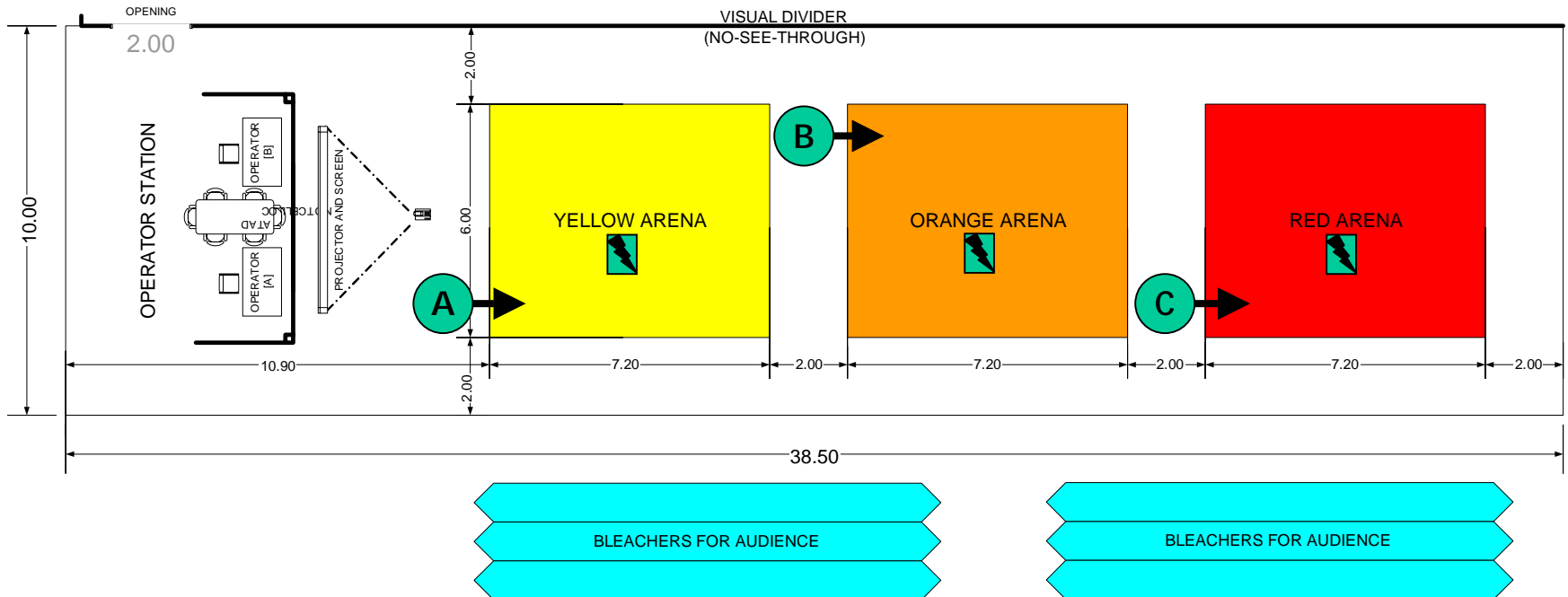



 A/C POWER  
20A @ 110V

DIMENSIONS  
IN METERS



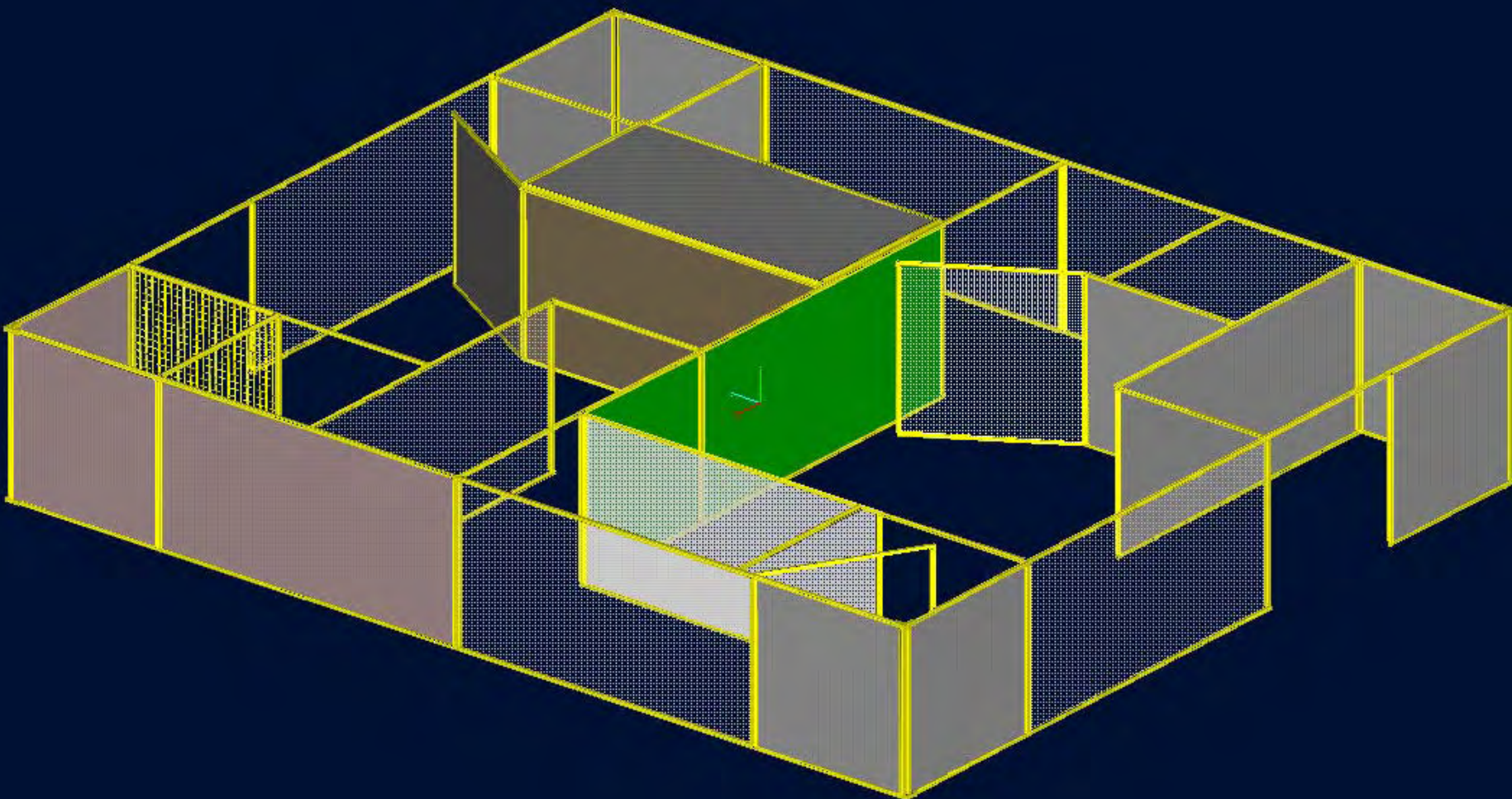
TEAM PADDOCK AREA  
[16 - 20 TEAMS]  
TABLES, CHAIRS, AND ROBOT AREA

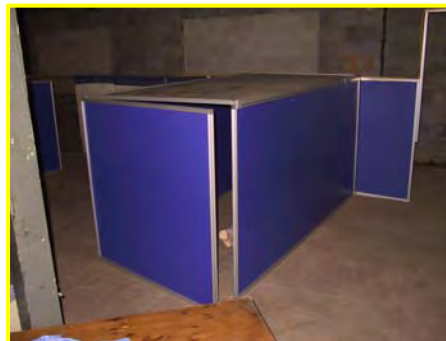
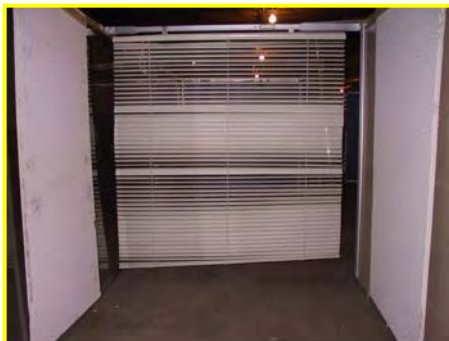
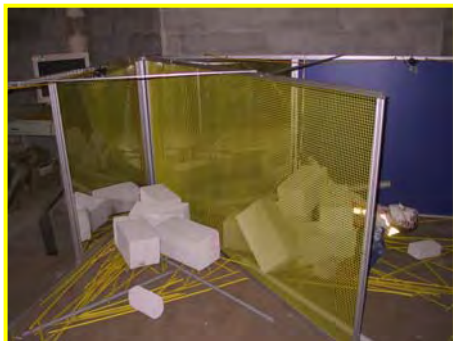


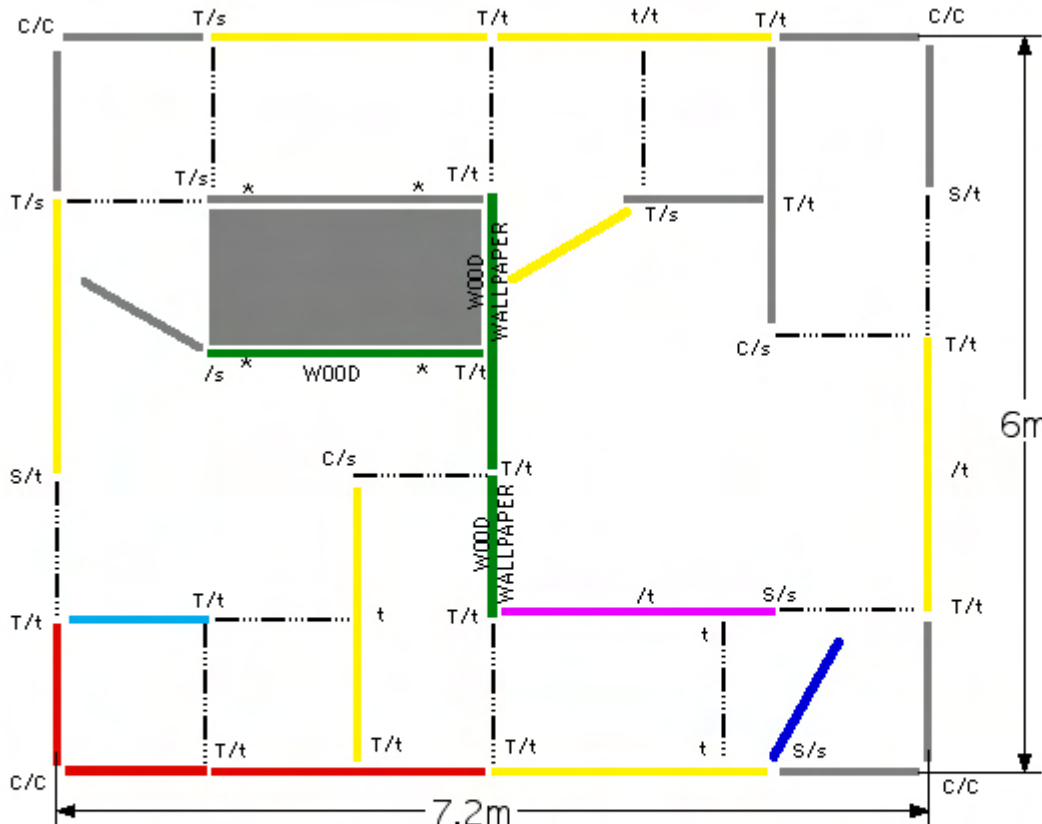
 A/C POWER  
20A @ 110V

DIMENSIONS  
IN METERS









YELLOW ARENA  
CONFIGURATION 1

| PANELS:        | SHORT | LONG |
|----------------|-------|------|
| CLEAR          | 2     | 6    |
| COLORED        | 12    | 4    |
| EMPTY          | 6     | 0    |
| HALF           | 2     | 0    |
| MESH           | 2     | 1    |
| MIRROR         | 2     | 1    |
| TRANSLUCENT    | 0     | 1    |
| WOOD/WALLPAPER | 2     | 2    |

| CONNECTORS:        | QUANTITY |
|--------------------|----------|
| C = CORNER         | 20       |
| S = LONG STRAIGHT  | 20       |
| s = SHORT STRAIGHT | 20       |
| T = LONG TEE       | 30       |
| t = SHORT TEE      | 30       |

CONNECTOR CONVENTION:  
TOP/BOTTOM

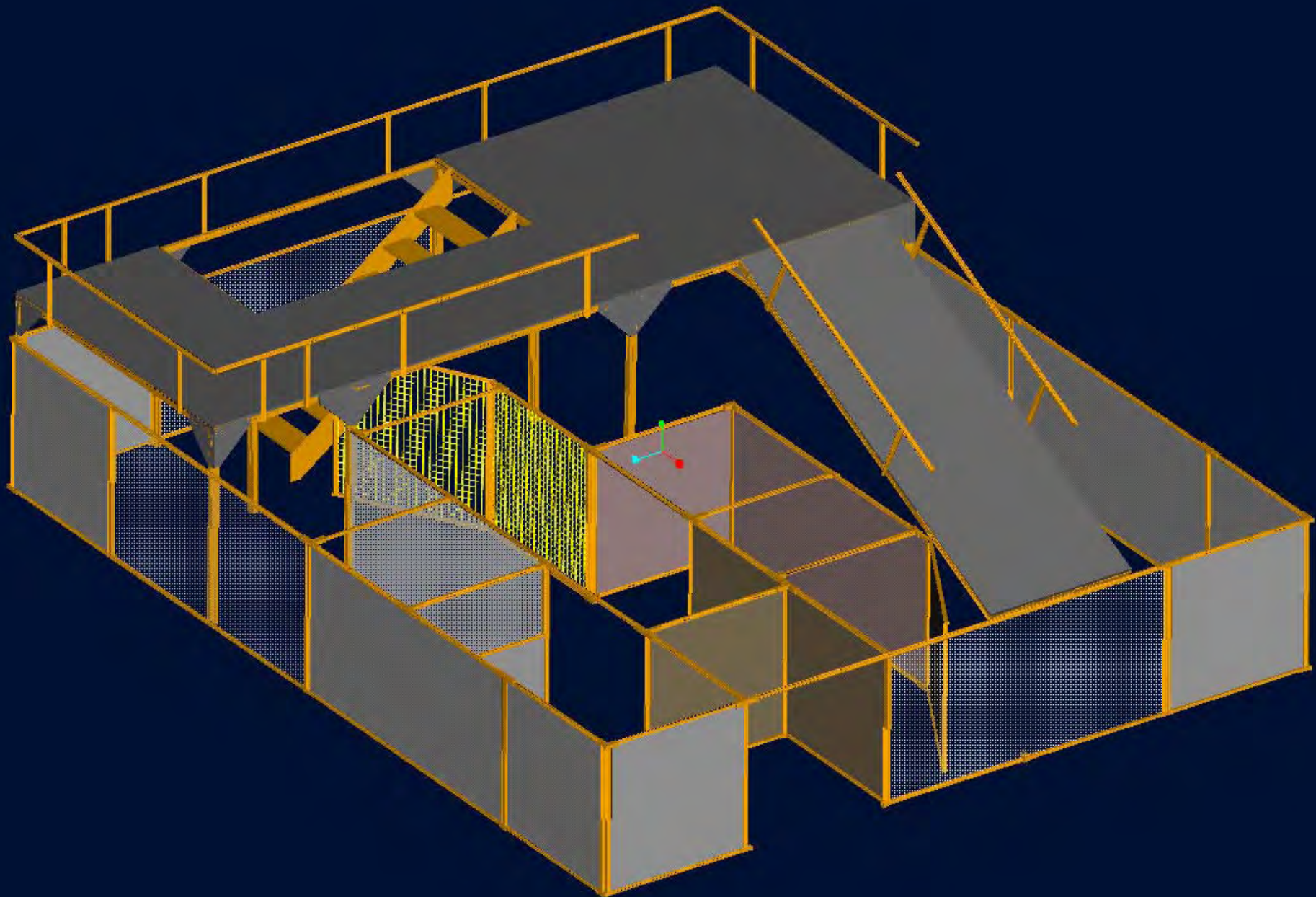
OTHER:  
--- SUPPORT  
\* SPECIAL CONNECTOR

**NOTE:**

SHORT PANELS:..... HEIGHT= 1.2m, LENGTH = 1.2m

LONG PANELS:..... HEIGHT= 1.2m, LENGTH = 2.4m

TOTALS SHOWN I INCLUDE NECESSARY SPARES

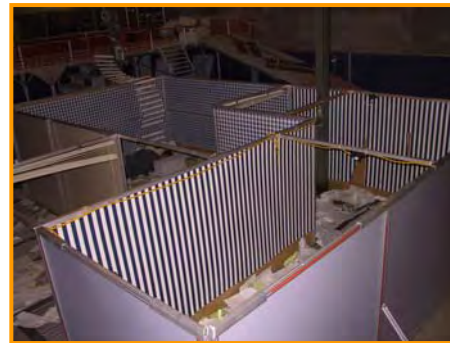


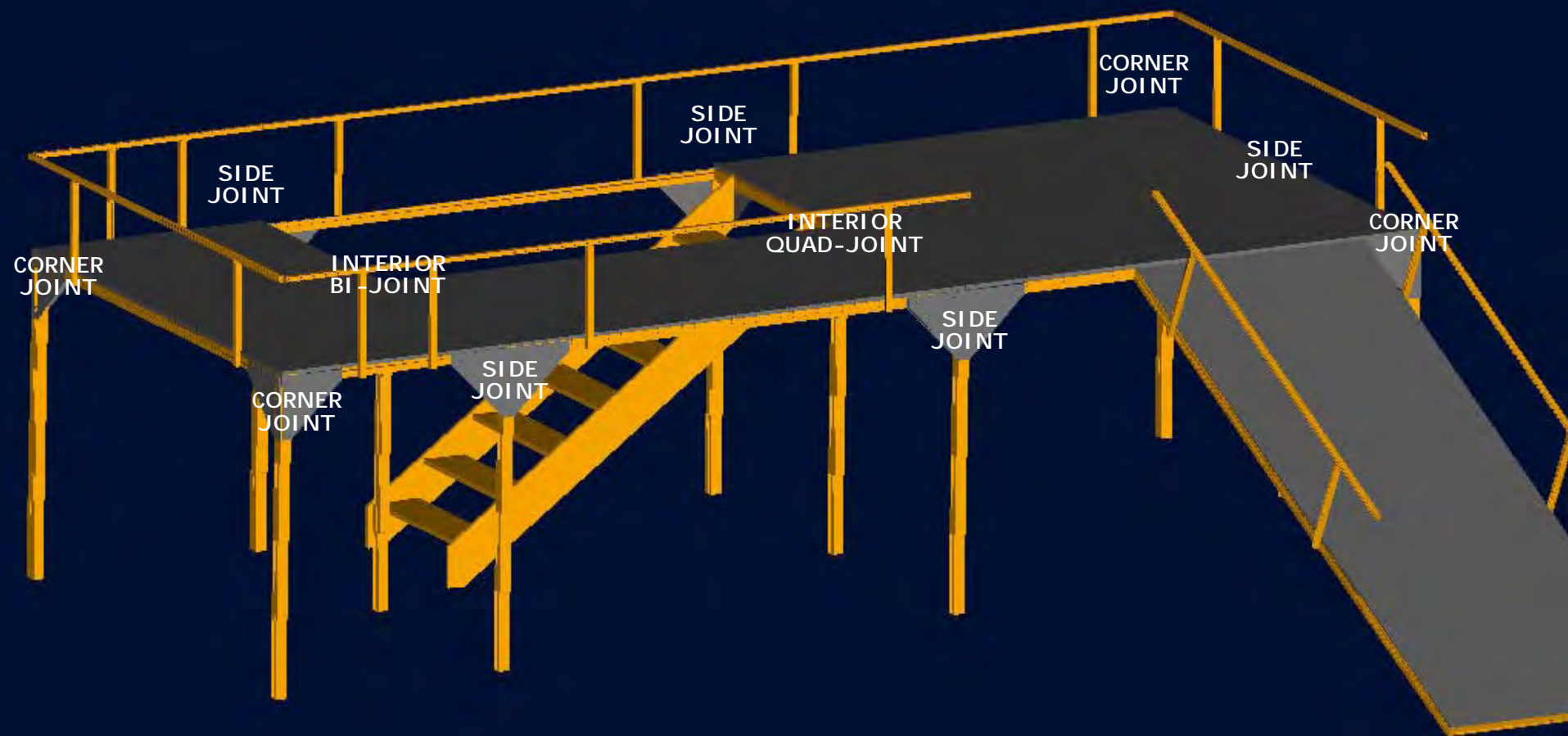
REFERENCE TEST ARENAS  
FOR  
URBAN SEARCH AND RESCUE ROBOTS

ORANGE ARENA  
MODEL VIEW

NIST







## CORNER JOINT (2 PLATES TOTAL)

EXTERIOR  
VIEW

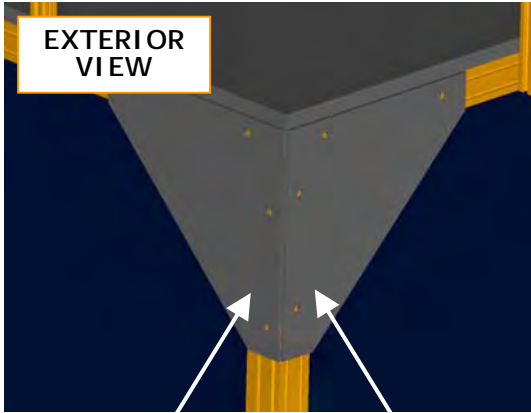
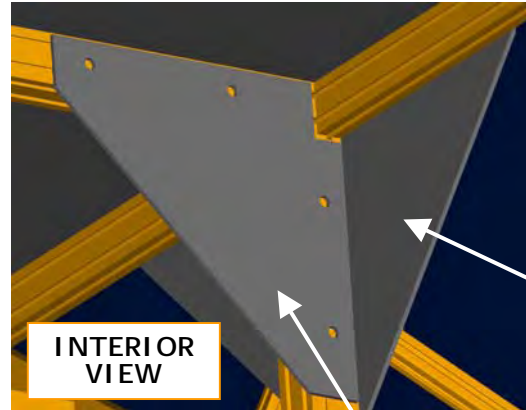


PLATE [A]

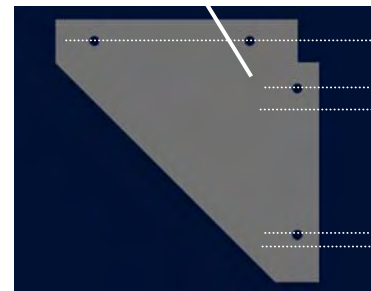
PLATE [B]

## SIDE JOINT (2 PLATES TOTAL)

EXTERIOR  
VIEW



INTERIOR  
VIEW



NOTE HOLE  
OFFSETS FOR  
BOLT CLEARANCE  
THRU POSTS

PLATE [C]

PLATE [D]

### NOTE:

ALL PLATES (EXCEPT PLATE [D]) HAVE OVERALL DIMENSIONS  
WIDTH (300mm) x HEIGHT (300mm) x THICKNESS (5mm)

PLATE [D] HAS OVERALL DIMENSIONS  
WIDTH (600mm) x HEIGHT (300mm) x THICKNESS (5mm)

THE NOTCHES IN PLATES [C], [E], AND [F] ACCOMMODATE FLOOR  
SECTION FRAMES

ALL BOLTS ARE M10

## INTERIOR X-JOINT (4 PLATES TOTAL - 2 OF EACH)

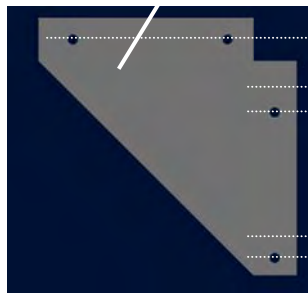
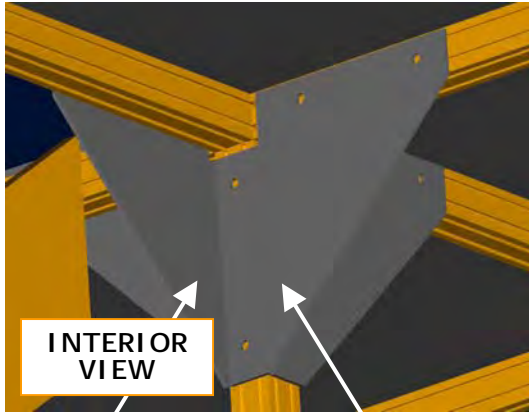


PLATE [F]



NOTE HOLE  
OFFSETS FOR  
BOLT CLEARANCE  
THRU POSTS

PLATE [E]

## INTERIOR T-JOINT (2 PLATES TOTAL)

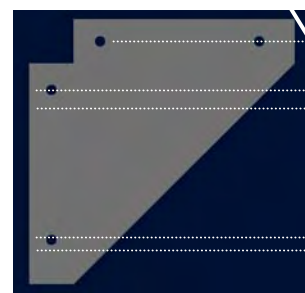
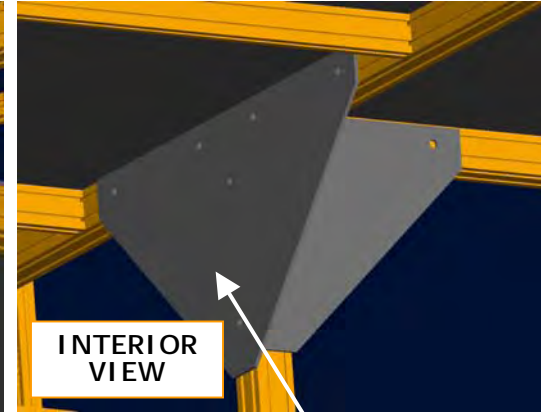
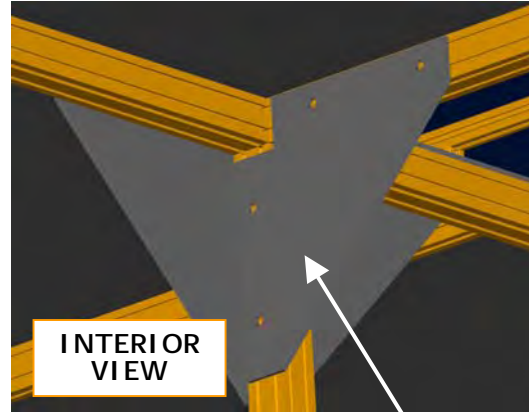
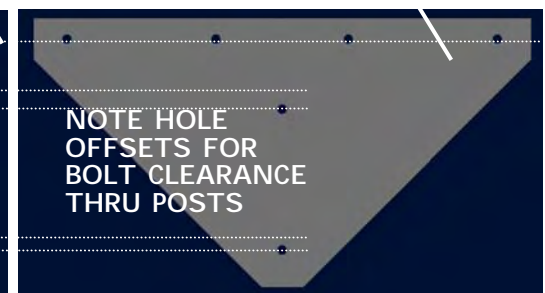


PLATE [E]



NOTE HOLE  
OFFSETS FOR  
BOLT CLEARANCE  
THRU POSTS

PLATE [D]

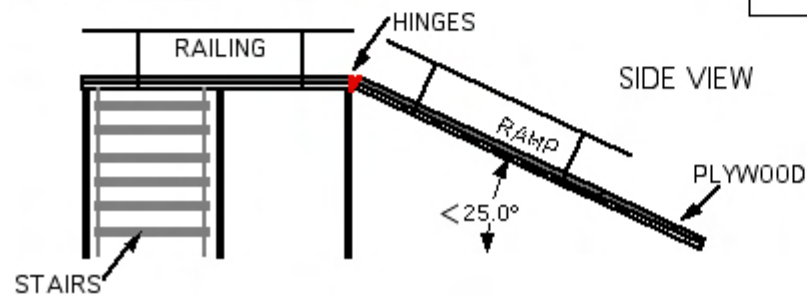
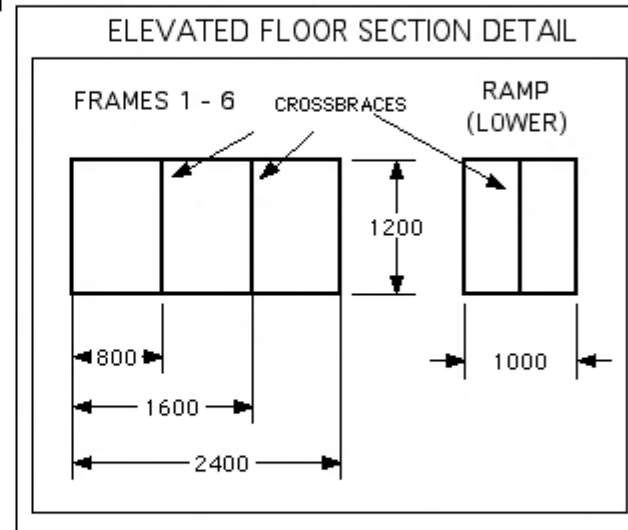
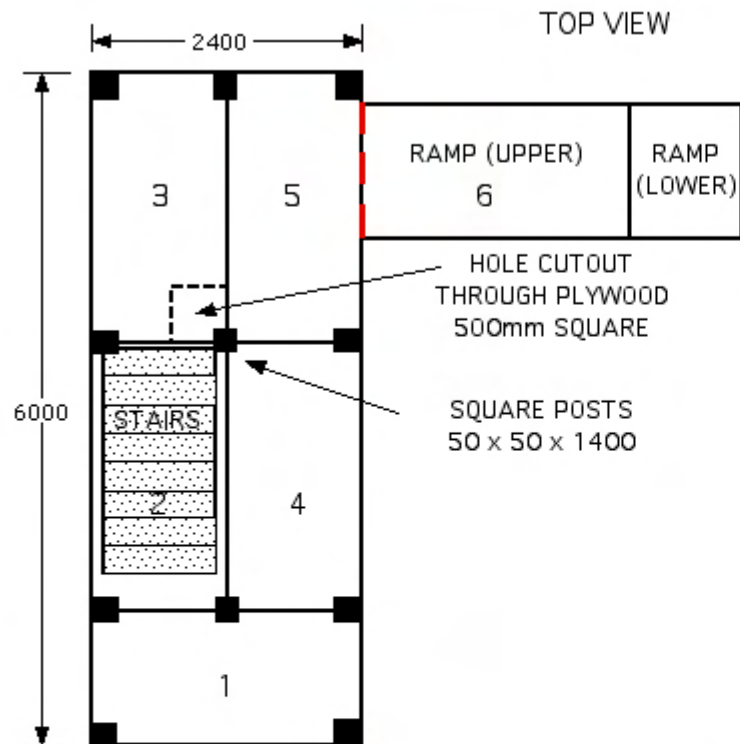
### NOTE:

ALL PLATES (EXCEPT PLATE [D]) HAVE OVERALL DIMENSIONS  
WIDTH (300mm) x HEIGHT (300mm) x THICKNESS (5mm)

PLATE [D] HAS OVERALL DIMENSIONS  
WIDTH (600mm) x HEIGHT (300mm) x THICKNESS (5mm)

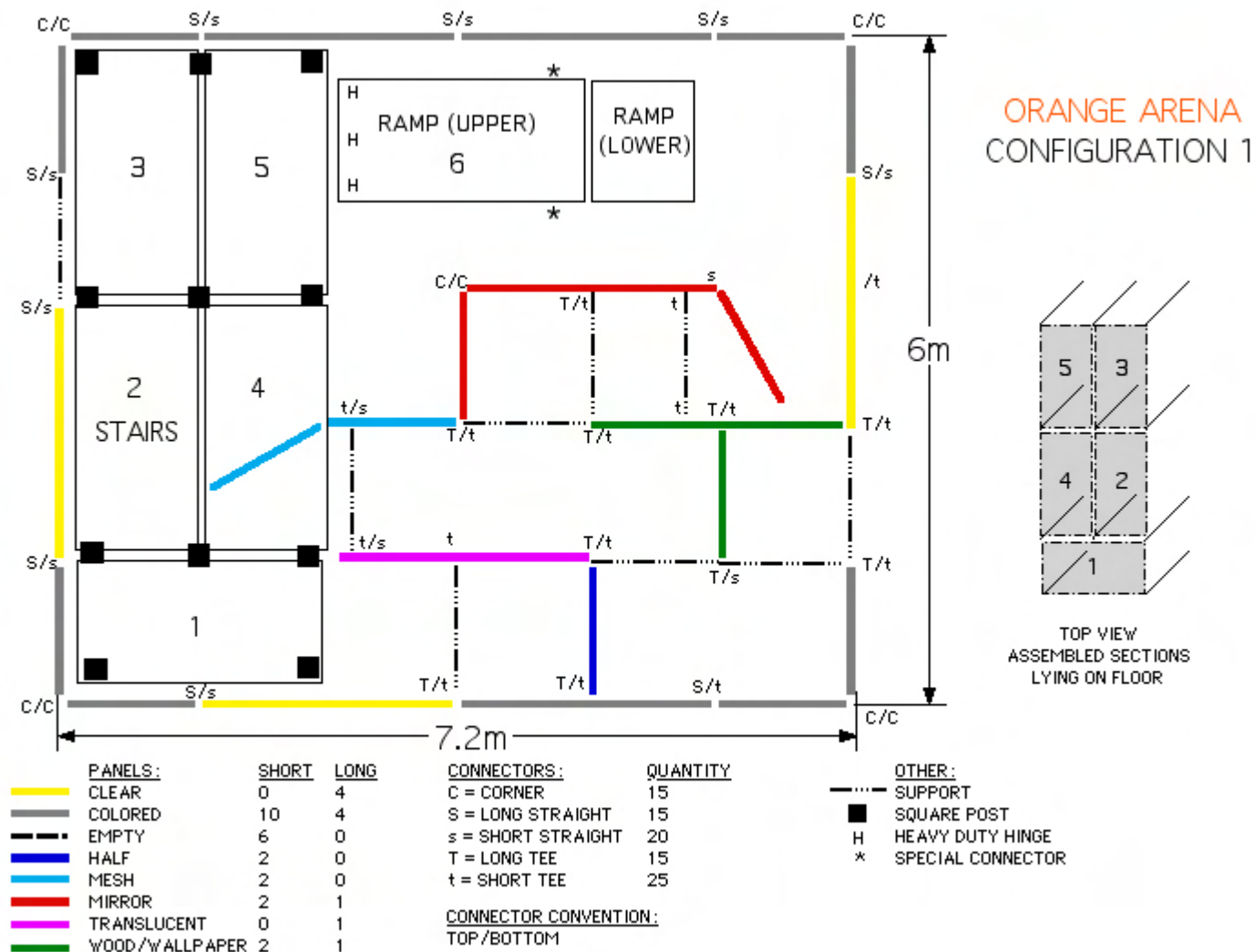
THE NOTCHES IN PLATES [C], [E], AND [F] ACCOMMODATE FLOOR  
SECTION FRAMES

ALL BOLTS ARE M10



**NOTES:**

ALL DIMENSIONS ARE IN MILLIMETERS  
 FRAMES 1-6 ARE EQUIVALENTLY SIZED SECTIONS THAT ARE AT LEAST 50mm THICK  
 EACH FRAME (EXCEPT #2) HAS AN EQUIVALENTLY SIZED PIECE OF PLYWOOD THAT IS AT LEAST 20mm THICK  
 THE STAIRS MUST BE ABLE TO FIT WITHIN FRAME #2 AND SHOULD BE MOUNTED DIRECTLY TO THE FRAME.

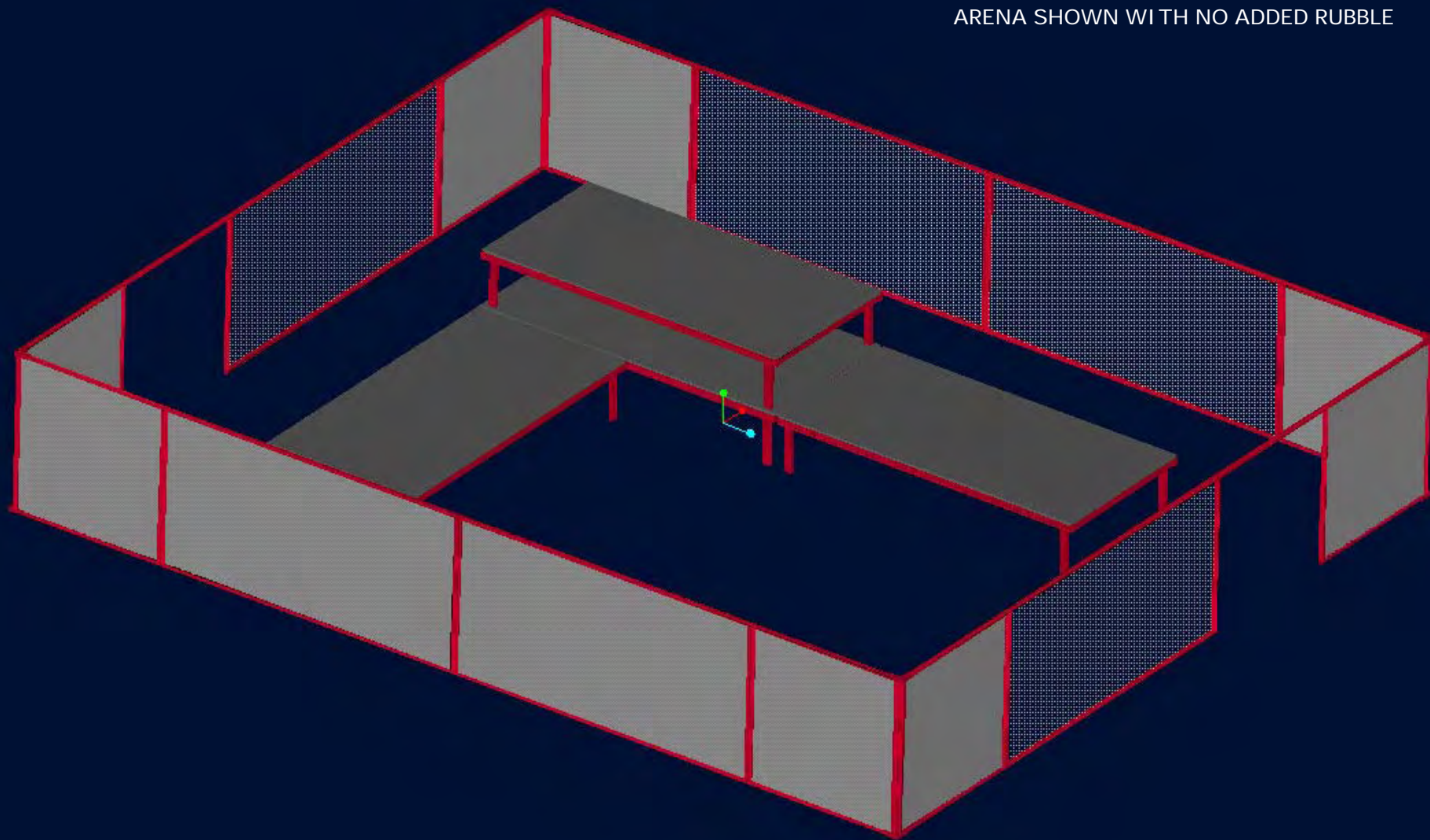


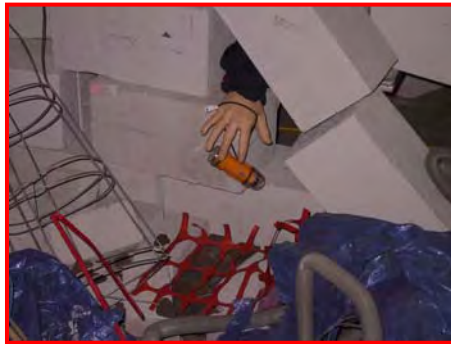
**NOTE:**

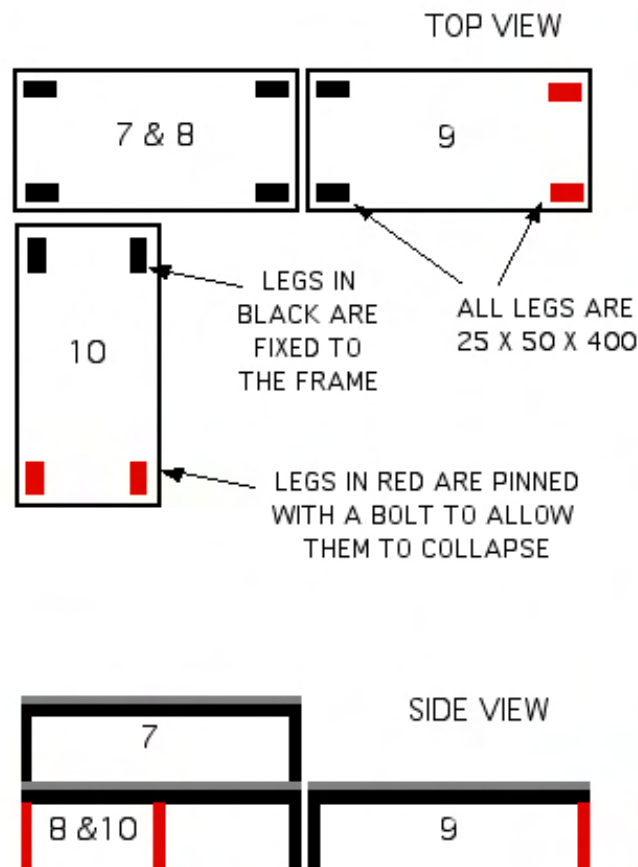
SHORT PANELS:..... HEIGHT= 1.2m, LENGTH = 1.2m  
LONG PANELS:..... HEIGHT= 1.2m, LENGTH = 2.4m

TOTALS SHOWN INCLUDE NECESSARY SPARES

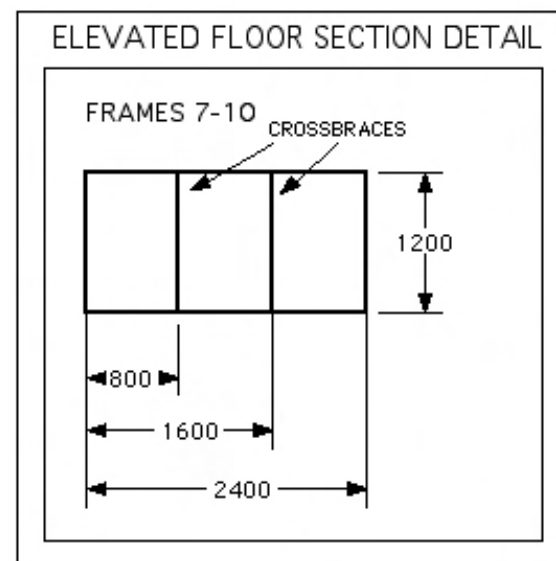
ARENA SHOWN WITH NO ADDED RUBBLE





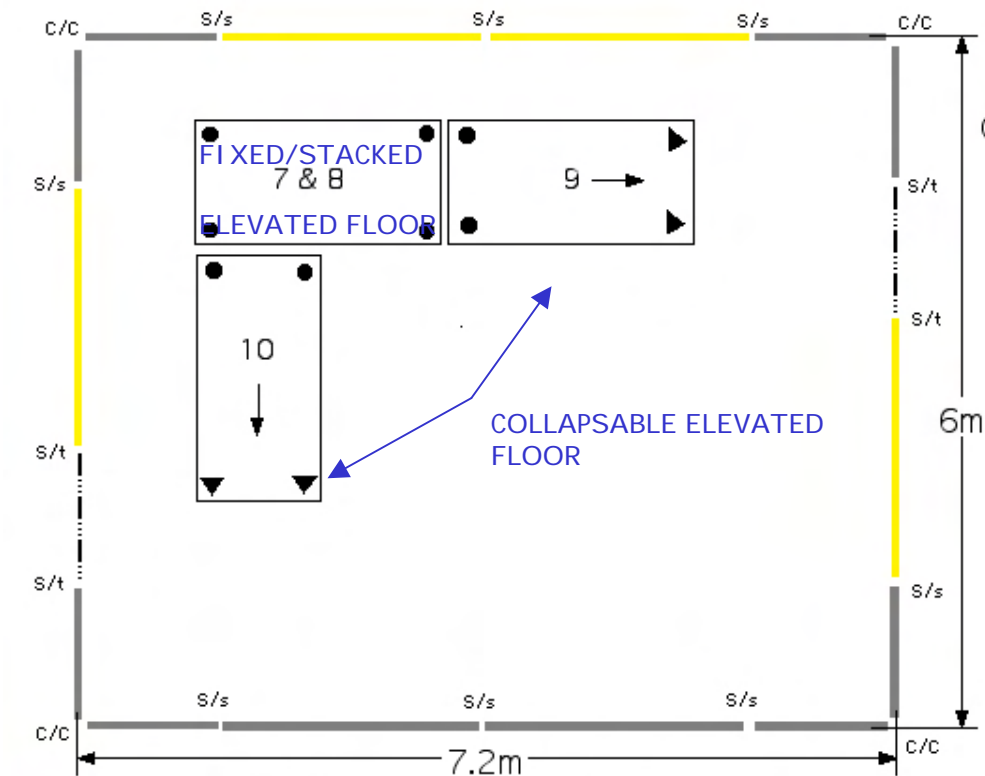


## COLLAPSIBLE AND PANCAKE FLOORING



### NOTES:

ALL DIMENSIONS ARE IN MILLIMETERS  
 FRAMES 7-10 ARE THE SAME AS FRAMES 6-10  
 FRAMES ARE AT LEAST 50mm THICK  
 EACH FRAME HAS AN EQUIVALENTLY SIZED PIECE OF PLWOOD  
 THAT IS ATLEAST 10mm THICK  
 FRAME 7 IS STACKED ON TOP OF FRAME 8



## RED ARENA CONFIGURATION 1

### NOTE:

ELEVATED FLOOR SECTIONS ARE SAME AS ORANGE ARENA ELEVATED FLOOR SECTIONS

SECTIONS 7 & 8 HAVE FIXED (50mm) LEGS AND ARE STACKED

SECTIONS 9 & 10 HAVE TWO FIXED (50mm) LEGS AND TWO PIVOTING (50mm) LEGS. ARROWS SHOW INTENDED DIRECTION OF COLLAPSE

| PANELS: | SHORT | LONG |
|---------|-------|------|
| CLEAR   | 0     | 4    |
| COLORED | 12    | 6    |
| EMPTY   | 4     | 0    |

| CONNECTORS:        | QUANTITY |
|--------------------|----------|
| C = CORNER         | 10       |
| S = LONG STRAIGHT  | 15       |
| s = SHORT STRAIGHT | 15       |
| T = LONG TEE       | 5        |
| t = SHORT TEE      | 5        |

CONNECTOR CONVENTION:  
TOP/BOTTOM

OTHER:  
● FIXED LEG  
▲ COLLAPSIBLE LEG

NOTE:  
FRAME 1 IS STACKED ON FRAME 2  
ARROWS INDICATE DIRECTION OF COLLAPSE

### NOTE:

SHORT PANELS:..... HEIGHT= 1.2m, LENGTH = 1.2m  
LONG PANELS:..... HEIGHT= 1.2m, LENGTH = 2.4m  
TOTALS PANELS SHOWN INCLUDE NECESSARY SPARES

ARENA SHOWN WITH NO ADDED RUBBLE



CLOTHING:  
DUST COVERED  
OR COLORFUL

MULTI-CULTURAL  
SKIN TONES

REFLECTIVE TAPE

LOCATOR STROBE

MOVING FINGERS  
AND ARMS

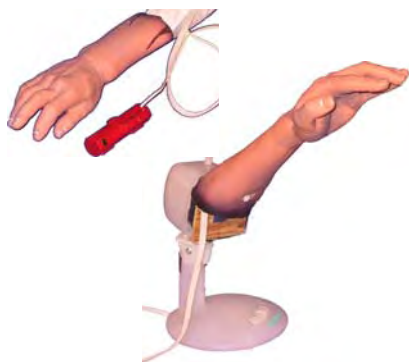
TAPPING

LOCATOR  
CHIRP

VOICE

BODY HEAT

CO<sub>2</sub> EMISSION



## BODY HEAT



HEATING BLANKETS ARE PLACED UNDER SIMULATED VICTIM CLOTHING TO SIMULATE BODY HEAT

HEATING PADS ARE ROLLED INTO HOLLOW ARMS TO SIMULATE BODY HEAT

## MOTION



OSCILLATING FANS ARE MODIFIED TO SIMULATE MOTION (REMOVE THE FAN, ATTACH THIN EXTENSION, SLIDE ARM AND HEATING PAD OVER EXTENSION)

MOVING FINGERS (BATTERY OPERATED GAG GIFTS) ALSO PROVIDE MOTION

## SOUND

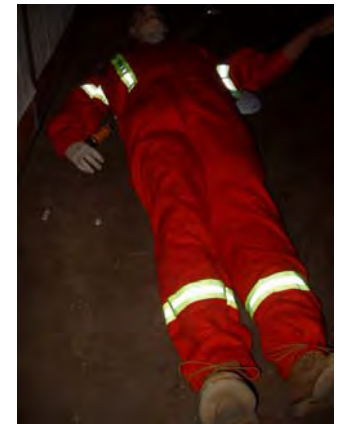


TAPE RECORDERS, WITH ENDLESS LOOP CASSETTES, CAPTURE AND PLAY ALL AUDIBLE SOUNDS (YELLING, MOANING, TAPPING...)

## OTHER



CO2 FILLED TANK, Y-VALVE, (2) 10m HOSES with FITTINGS PROVIDE EMISSION SOURCES



| Category                | Quantity | Part Name  | Part Number              | Vendor             | Website  | Cost/per     | Total             |
|-------------------------|----------|--|--------------------------|--------------------|--|--------------|-------------------|
| <b>VISUAL TARGETS</b>   |          |  |                          |                    |  |              |                   |
| Mannequins              | 9        | The least expensive adult mannequin product lines are the 'Rudy' and 'Judy' series. Children and ethnically diverse mannequins are also available from this company, but they cost more. The cost/per line is an average of the Rudy/Judy series prices. |                          | Econoco            | <a href="http://www.econoco.com">www.econoco.com</a>                   | \$170.00     | \$1,530.00        |
|                         |          |  |                          |                    |  |              |                   |
|                         |          |  |                          |                    |  |              |                   |
|                         |          |  |                          |                    |  |              |                   |
| Baby dolls              | 6        |  |                          | Toys'R Us          | <a href="http://www.toysrus.com">www.toysrus.com</a>                   | \$20.00      | \$120.00          |
| Arms                    | 3        | Right Arm  |                          | Alarming products  | <a href="http://www.alarmingproducts.com">www.alarmingproducts.com</a> | \$17.99      | \$53.97           |
|                         | 2        | Left Arm   |                          |                    | <a href="http://www.chamberofhorrors.com">www.chamberofhorrors.com</a> | \$17.99      | \$35.98           |
|                         |          |  |                          |                    | <a href="http://www.halloweenmart.com">www.halloweenmart.com</a>       |              |                   |
| Strobe Light            | 4        | ESL Rescue Strobe  | Product ID: <b>ESLR1</b> | Conterra           | <a href="http://www.conterra-inc.com">www.conterra-inc.com</a>         | \$19.95      | \$79.80           |
| Rescue Wear             | 2        | Fitted Proban FR Suit  | SKU ERTSUIT              | ProBuy             | <a href="http://www.probuy.net">www.probuy.net</a>                     | \$129.00     | \$258.00          |
|                         | 3        | Orange Mesh Vest   | SKU TV15RSC              |                    |  | \$8.95       | \$26.85           |
| Civilian Clothing       | 7        | Shirts, Pants, Other   |                          | Any Clothing Store |  | \$30.00      | \$210.00          |
| <b>THERMAL TARGETS</b>  |          |  |                          |                    |  |              |                   |
| Heating Blankets        | 15       | Sunbeam Electric Blanket   | Twin Size                | Walmart            | <a href="http://www.walmart.com">www.walmart.com</a>                   | \$26.97      | \$404.55          |
| Heating Pads            | 16       | Sunbeam Heating Pad  | 790962                   | Kmart              | <a href="http://www.kmart.com">www.kmart.com</a>                       | \$10.99      | \$175.84          |
| <b>MOVING TARGETS</b>   |          |  |                          |                    |  |              |                   |
| Moving Arms             | 3        | Small Oscillating Fan  | 56420                    | Lowes              | <a href="http://www.lowes.com">www.lowes.com</a>                       | \$7.87       | \$23.61           |
| Moving Finger           | 5        | Wiggling Hand  | Code: <b>LO13-0033</b>   | halloweenmart.com  | <a href="http://www.halloweenmart.com">www.halloweenmart.com</a>       | \$14.99      | \$74.95           |
| <b>AUDIBLE TARGETS</b>  |          |  |                          |                    |  |              |                   |
| Tape Recorder           | 11       | Cue/Review/Recorder  | Cat.#: 14-1118           | Radio Shack        | <a href="http://www.radioshack.com">www.radioshack.com</a>             | \$29.99      | \$329.89          |
| Tape Cassetts           | 11       | 30-Second Continuous loop  | Cat.#: 43-402            | Radio Shack        |  | \$5.29       | \$58.19           |
| <b>CHEMICAL TARGETS</b> |          |  |                          |                    |  |              |                   |
| CO2 Emission            | 1        | 20 lb. CO2 Cylinder  |                          | Roberts Oxygen     | <a href="http://www.robertsoxygen.com">www.robertsoxygen.com</a>       | \$154.00     | \$154.00          |
|                         | 1        | 20 lb. CO2 Contents  |                          |                    |  | \$10.00      | \$10.00           |
|                         | 1        | Flowmeter  |                          |                    |  | \$80.92      | \$80.92           |
|                         | 1        | Inert Y connections  |                          |                    |  | \$28.17      | \$28.17           |
|                         | 2        | Hose w/fittings (7m length)  |                          |                    |  | \$2.00       | \$4.00            |
|                         |          |  |                          |                    |  |              |                   |
|                         |          |  |                          |                    |  |              |                   |
|                         |          |  |                          |                    |  |              |                   |
|                         |          |  |                          |                    |  | <b>TOTAL</b> | <b>\$3,658.72</b> |

**SHORT PANELS**  
(HEIGHT = 1.2m, LENGTH = 1.2m)



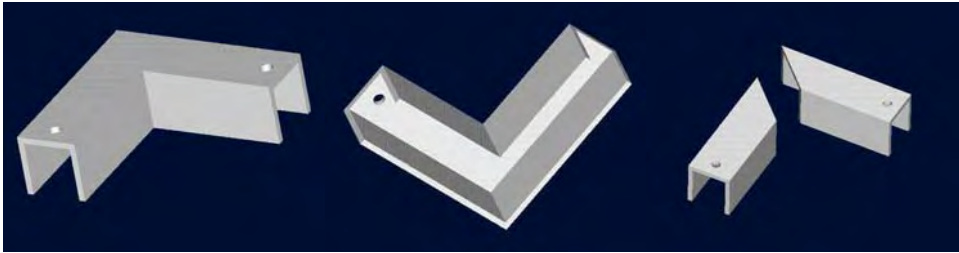
A VARIETY OF COLORED, TEXTURED, AND CLEAR PANELS  
ARE CAPTURED INSIDE ALUMINUM EXTRUSION FRAMES



**LONG PANELS**  
(HEIGHT = 1.2m, LENGTH = 2.4m)



### CORNER (100mm and 100mm)



### SHORT TEE (50mm and 100mm)



### LONG TEE (100mm and 200mm)



#### NOTES

- ALL CONNECTORS ARE ALUMINUM C-CHANNEL
- C-CHANNEL SHOULD CLOSELY FIT OVER WALL PANEL FRAMES
- CUTTING AND EXTERNAL WELDING REQUIRED
- CENTERLINE HOLES/FASTENERS SECURE CONNECTORS RIGIDLY

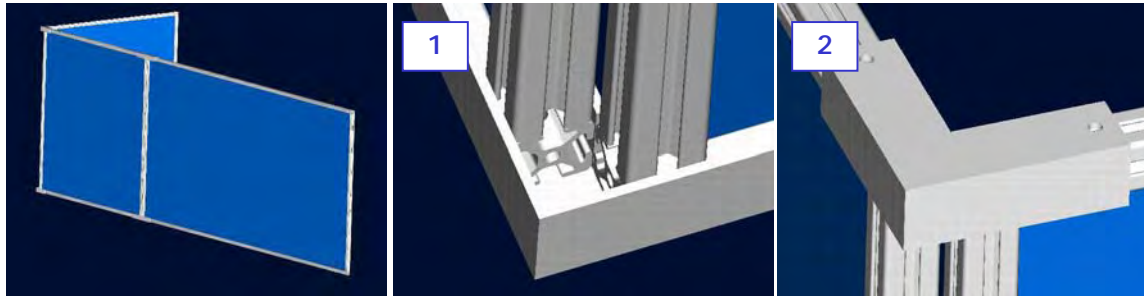
### SHORT STRAIGHT (100mm)



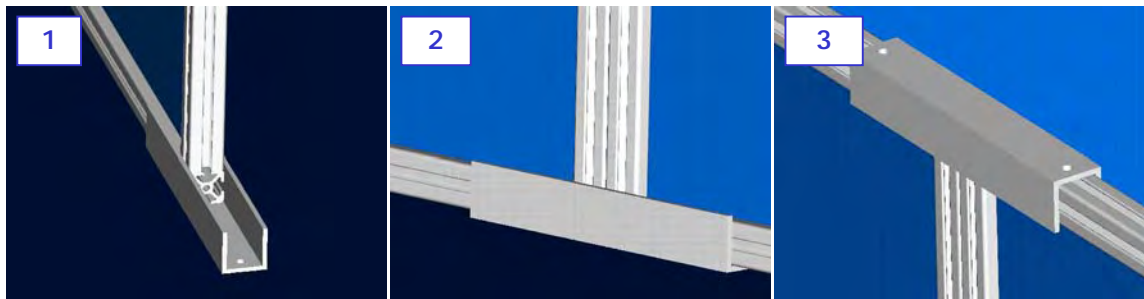
### LONG STRAIGHT (200mm)



## CORNER ASSEMBLY

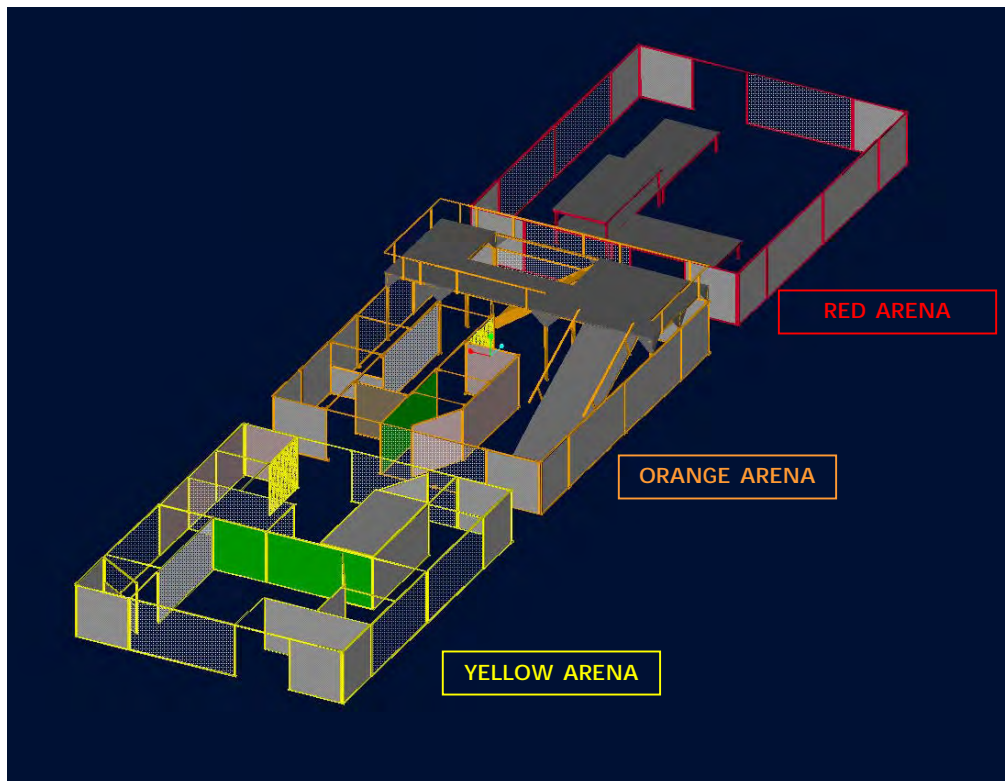


## STRAIGHT ASSEMBLY



## TEE ASSEMBLY





FOR MORE INFORMATION...

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and BRIAN WEISS

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301-975-4235*